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Experimental Research of RFID Aided Healthcare Management Approach using IOT with Deep Learning Paradigms

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***Abstract*—**

Nothing is precious then health. In today's era to monitor the health at regular intervals and on time to time is very easy by the tools and smart application based equipment available in market. Internet of things makes the life support equipment to available easily whether people are at local end or at the remote end. So that the doctors at far distant or the near they can easily check the patients. This article focuses on the designing of a health care monitoring system by using the latest technologies like deep learning, IoT and RFID. All are emerged together to make a reliable and secure healthcare surveillance approach by digital means.

***Index Terms*—**RFId, IoT, Deep learning, Healthcare

I. INTRODUCTION

The field of Bio-Medical Engineering attains a lot of modifications in recent days along with the adaptation of several latest technologies and its associated applications. This field utilizes the benefits of latest technologies to provide a sufficient support to the patients as well as their guardians in perfect manner. Several smart Android based applications are developed to provide convenient monitoring of health care of the patients with intense support. However, all these technological associations are strucked into certain limitations such as low performance, high costand require lot of technical support. Health care is a necessary source of survival, but the ageing population and associated epidemic disease are putting enormous strain on current healthcare organizations [1], with a significant allocations of resources ranging from emergency rooms to physicians and surgeons [2]. Clearly, a solution can be found to alleviate burden on healthcare infrastructures while still providing high quality care to the patients. The term Internet of Things (IoT) adopts the interest of several researchers and utilizing the technological field applications entirely with its robustness. Many industrial applications utilizing the IoT logic into their smart devices to make a bridge between local device to the remote server in user-friendly manner [3][4].

But the adaptation of such methodology to the health care field causes certain difficulties in literatures such as health care surveillance data security, performance and so on. Therefore, the technology is applied over the bio-medical field in limited manner. As well as the logic of data mining, machine learning and associated classification principles are playing a drastic role in several industries to predict their organizational data in an efficient manner. In order to attain such benefits into the health care field a new methodology is required to provide an

efficient health caremonitoring system with the support of latest technologies. The logic of deep learning strategies are popular now-a-days to predict the scenario based on the given dataset, in which thesepredictions are helpful in several fields such as agriculture, commercial and non-commercial industries. This logic of deep learning is adapted into the proposed approach with modulated manner. A conventional Deep Neural Network strategy is considered over the proposed approachto design a new protocol for monitoring the health care system in an intense manner. The classicalDNN methodology is operating according to the principles of Artificial Intelligence and the multiple layer based processing approach is followed to predict the results with respect to the giveninput.

These are some of the major benefits of neural networks is that it enables the solution of challenging issues involving the discovery of underlying statistical analysis and a thorough grasp of the complicated interconnections between a substantial percentage of related processes. Although the terminology of deep-learning may seem fancy as well as it refers to a subset of neural network models and similar technologies that utilize frequently extremely unprocessed input information. The learning concept processes this information over layers and layers of temporal data in necessary to come at an expected outcome. The following figure, Fig-1 shows that how would data science schemes scale the datasets as grow in size. From this graphical illustration it is easy to identify the efficiency of the deep learning principles in clear manner.

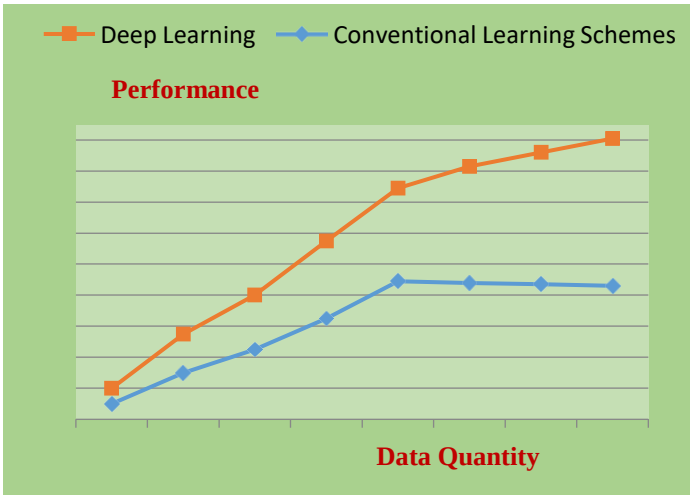

Fig.1 Deep Learning vs. Conventional Learning Schemes

The logic and importance of deep learning principles are clearly known with respect to the mentioned figure, Fig-1 and the logic of every technology associated with the proposed health caremonitoring scheme is illustrated in detail with all specifications as further.

A. Radio Frequency Identification (RFID)

The Radio Frequency Identification (RFID) module is generally used for security enhancements over industries, organizations and related environments. The provisions provided by RFID readerand tags are so important in many smart applications due to its high performance and low-cost. RFID is a wireless recognition methodology made up of two constituents such as RFID Tags and RFID Readers. A RFID reader is an electronic device equipped with one or multiple antenna(s) that transmit electromagnetic radiation and receives information signals from a respective RFID card/tag. RFID is an information gathering

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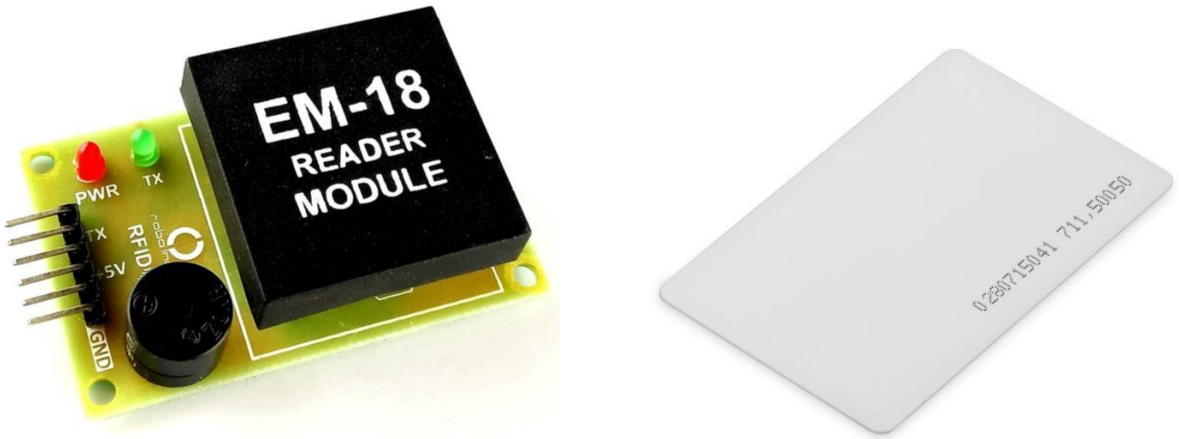
process that provides decreased power consumption model and low power wireless radio signals to systematically recognize the waves. A technology comprised of RFID cards/tags, corresponding antenna, an RFID reader and a signal generator, in which these components are used to transmit and receive information. In this proposed approach of health care monitoring scheme, a powerful RFID reader is utilized called EM-18 RFID reader. This is a 9-pin smart reading device, in which it operates basically on seven connected pins and two remaining pins are data indication to identify the binary data from the module such as LOW or HIGH. This EM-18 RFID reader operating with the frequency of 125 KHz and the required power source is 12v DC. This RFID reader module consists of buzzer unit to indicate the card/tag reading identification and the transmitter pin (Tx) is used to transmit the read signals to the controller for further evaluation. This module comes with an integrated antenna and the communication parameter specification is around 9600 bits per second. The following figure, Fig-2 (a) and (b) illustrates the perception of proposed EM-18 RFID reader and the associated tags inclear manner.



(a) **(b)**

Fig.2 (a) EM-18 RFID Reader and (b) RFID Card

This particular EM-18 RFID reader and the associated 125 KHz RFID cards are used to operatethe client end to monitor the health care summary of the patients from anywhere in the globe. This is acting as an authentication credential of the guardians to prove their identity into the system to monitor the respective patient details in proper manner. Along with this verification, some more security validations are available to cross-validate the authentication of the respective user such asusername, password and one time password generated randomly by the machine over runtime. Therefore, by the utilization of this RFID based health care surveillance adds a huge benefit to thisproposed approach in intense manner.

B. Internet of Things (IoT)

An internet plays a major role in day-to-day life of every individual as well as all are using the smart mobile phones to surf for several things globally. Internet of Things (IoT) is a very recent subject of research and its promising technologies and applications are still in their development. This section provides the description of IoT based health care monitoring scheme and its applications to support health care industry. The proposed scheme illustrates some experimental efforts to establishing health care Smart devices with IoT assistance. Mostly on the premise of common trends in this summary, a comprehensive and standardized architecture is suggested for prospective earlier part Internet of Things enabled health care schemes, also with goal of directingtheir continued prospects [5][6].

This leads a high potential to communication industry to grow in literal manner as well as the associated technology services also gain a benefit. The internet enabled service medium called Internet of Things (IoT) attains a great benefit regarding this growth and provides a vast of services to its clients in intense manner. The logic of IoT is associated with many applications to make it as a smarter one as compared to the classical applications. Generally this Internet of Things logic provides an inter-connection between real-time devices and the respective server. The collection of real-time data is gathered and forward that to the server end for processing. This IoT logic helpsto attain that in proper manner without any time delay constraints. In this paper, Internet of Thingsis utilized to operate in a bidirectional manner, in which the health records are accumulated from the sensor unit and pass it to the server end as well as the data or trigger is collected from the server end to the controller unit of the smart device. These operations are handled by using the specific Internet of Things module. This proposed approach used a model of ESP32 to enable the internet services via WiFi. This is a portable WiFi chip, in which it is integrated with the default controller to accommodate the code part to operate the connected sensors accordingly. The following figure,Fig-3 illustrates the overall schematic view of the proposed smart device with associated ESP32 WiFi module integration.

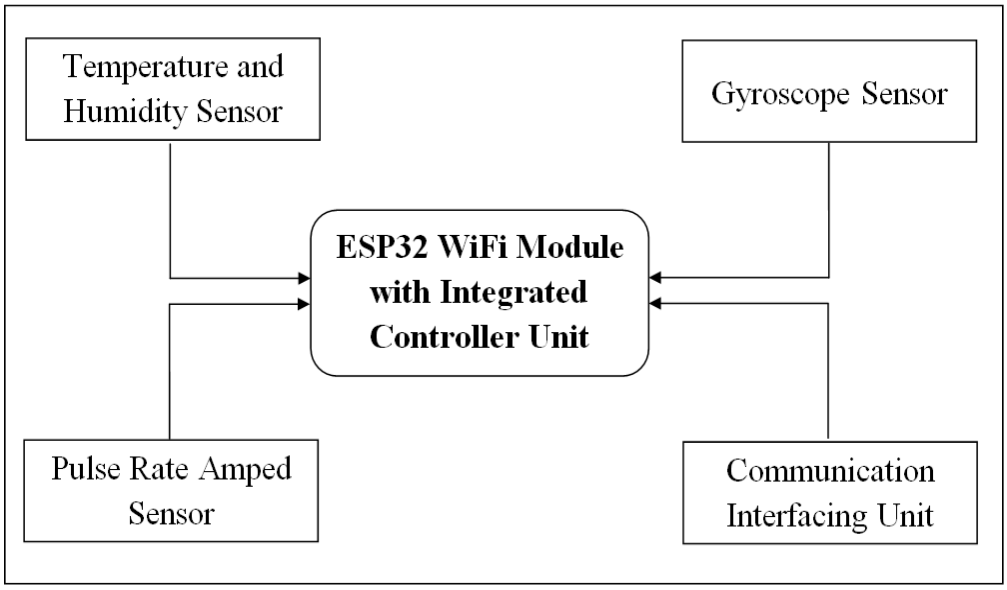


Fig.3 Schematic View of HealthCare Monitoring Device

C. Sensor Unit with Deep Learning Principles

The proposed logic of health care monitoring system is carried out by means of an intelligent sensor unit presented into the smart device. These sensors are integrated for different purposes andit creates a logical power to the smart device. The DHT11 based temperature and humidity sensor is used in this approach to identify the levels of temperature and humidity over the circumstance. The amped sensor is used for estimating the pulse rate levels of the patient and the gyroscope sensor is used to identify the patient body position such as normal or abnormal. These sensors operate properly and accumulate the readings from the specific patient with respect to present body condition. The collected values are reported to the controller for evaluation.

The controller accumulates the sensor readings and transfers those readings to the server unit for processing by using ESP32 WiFi. The server end receives the health data to process it

accordinglybased on the dataset. In this application, the dataset is a customized one based on the earlier healthrecords accumulated from the previous patient summaries, in which the new patient records are manipulated and it will be going to append into the dataset for future processing. The data available into the dataset is considered to be the training data and the record which is accumulated presently from the smart device is considered to be the testing data. The present data is cross validated fromthe trained model and the resulting scenario is returned to the user as a prediction. This paper utilizes the approach of Intense Learning Principle (ILP) to attain the high accuracy because the logic is derived from the conventional learning strategy of DNN. The resulting section provides the proper graphical outcome to prove the terminologies in clear manner. The following figure, Fig-4 illustrates the overall process view of the proposed approach in clear manner with graphicalillustration, in which it shows how the proposed health care monitoring and prediction scheme works in detail.

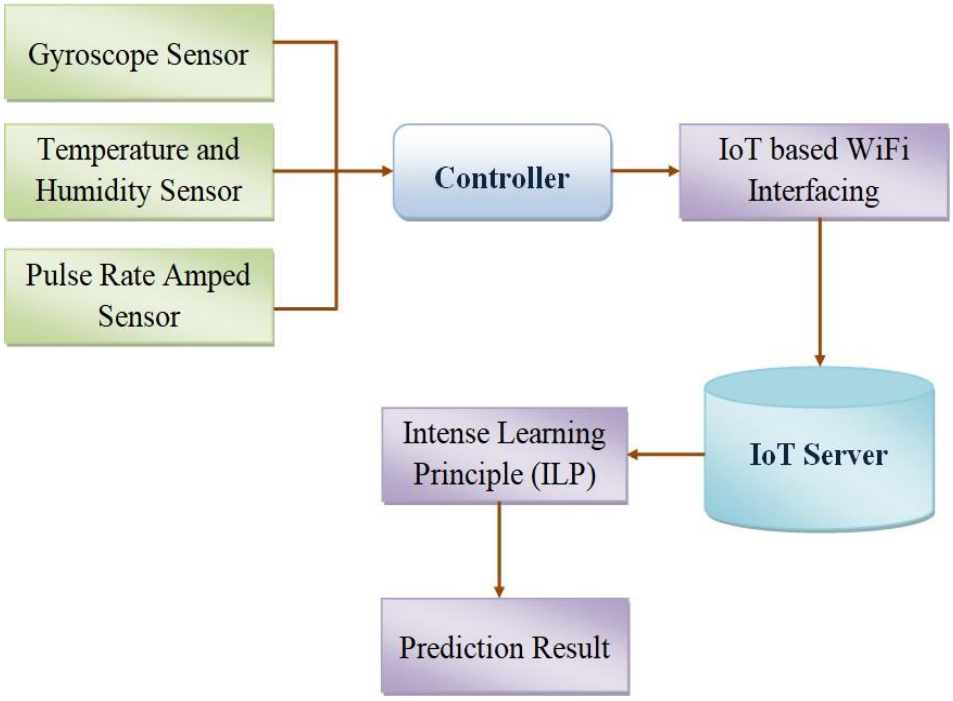


Fig.4 Systematic Flow of Proposed Approach

II. RELATED STUDY

Gayathri et al., 2019 [6] proposed a paper related to reliable and scalable proficient data with collective authentication mechanism for Wireless-Medical-Sensor-Networks (WMSN) in Health care industry. In this paper [6], the authors illustrated such as: Significant gains in wireless technologies also led to the establishment of real world applications including such infrastructure surveillance, disaster surveillance, pollution management and health care monitoring. In such scenarios, researchers might merge wireless networks with the IoT devices, in which sensors periodically connect to the network and utilize it to communicate as well as perform tasks. Remote communication routing protocols periodically review and acquire biomedical signals through an smart health care system as well as communicate it to health care professionals via Internet of Things entities. Numerous identification approaches have been described in the literature to circumvent device communications and processing restrictions and to provide confidentiality in health care wireless sensor network for medical systems. Furthermore, the majority of these methods are vulnerable to a variety of threats.

Thus, to maintain the safety and confidentiality of health information, a pairing free collective authentication approach [6] is suggested for WMSN in an authentication protocol system in this study [6] and several aggregation techniques are employed [6] in an authentication protocol framework in terms of minimizing complexities and communication inefficiency regarding data transmission. This approach [6] achieves complete consolidation in attempt to optimize information dissemination, and performance assessment demonstrates that perhaps the suggested system is better.

Ju-Ren et al., 2019 [7] proposed a paper related to secure information consolidation of low power IoT enabled smart health care gadgets with equitable motivation. In this paper [7], the authors illustrated such as: Patients outfitted with resource-constrained smart health care devices such as Internet of Things (IoT) create massive amounts of medical information for healthcare services due to the fast development of smart health care systems. Because once consolidated from all of these scattered gadgets, these healthcare information have great medicinal properties. Moreover, improved healthcare data processing has various privacy concerns, including leakage of sensitive information and asymmetric cyber attacks and patients may be unwilling to give their medical information for consolidation. A privacy preserving health data aggregation technique is presented in this research [7] that effectively aggregates medical information from diverse sources and ensures that subscribing users report with appropriate benefits. Especially, signature approaches are used to ensure that patients receive equitable benefits. Simultaneously, noises are introduced into medical information to achieve semantic segmentation. Additionally, the Boneh Goh Nissim cryptographic algorithm is integrated with Shamirs' crypto system based data sharing in ensuring information obscurity protection as well as failure tolerance. Privacy concerns talks demonstrate in this method [7], in which it is capable of withstanding differentiated cyber attacks, tolerating health care center malfunctions and maintaining equitable patient preferences. Formative assessment substantiates the minimal prices of computing, connectivity and archiving.

Subahi et al., 2019 [8] proposed a paper related to specifications, suggestions and schematic architecture for an edge based Internet of Things assisted health records maintenance System. In this paper [8], the authors illustrated such as the architectural design, development and suggestion for an Internet of Things-based health care management program. The proposed architecture [8] intends to distribute the effort associated with network efficiency (smart health care service providers), such as surveillance, diagnosing and forecasting as well as monitoring and preserving individual health information, among the service's many locations. The suggested proposed framework [8] is composed of two major components, in which one for monitoring tasks and the another one for health information management activities. These components communicate with a number of different relational databases such as SQL and MySQL. This study [8] makes a significant contribution by presenting an inspirational motivation remote support mechanism and n the structural space of conversion elements, two different kinds of transformations arrangementare addressed.

Changbo-Ke et al., 2019 [9] proposed a paper related to the architecture for enforcing integrity in Software-Defined-Network based information exchange platforms in intelligent health care. In this paper [9], the authors illustrated such as just a diverse health paradigm, smart health care has the ability aimed at providing patients with more accurate and scalable healthcare services. Furthermore, because significant quality requires patients to submit biomedical parameters for electronic diagnosis, if somehow the data privacy infrastructure for e-health is insecure, this confidential data may be misused by unlawful or criminal individuals. Additionally, significant quality must address several novel difficulties, including IoT devices, data theft attacks and insider threats. To address these issues, a security

enforcement system is offered for data communicationplatforms in patient monitoring that is built on Software-Defined-Network. Every patient in this architecture [9] has a specialized Linux distribution in the information exchange platform; also every virtualization delivers a collection of data services that are provided to authorized service providers or IoT devices. Additionally, the software application is secured by an Software- Defined-Network based portal that acts as a gateway as well as ensures that only authorized entities may access the patient's virtual machine. Due to the fact that every object has a unique address, this system [9] is capable of successfully authenticating source of energy connected technologies thus addressing issues associated with fraudulent activity. To demonstrate the application's efficacy and viability, an advanced method is developed utilizing a POX microcontroller and a Mini-net simulator. Experiments demonstrate that our method is successful in a variety of assessment circumstances. As even the complexity of the information sharing paradigm is increased, the architecture can continue to function properly as well as its efficiency can remain adequate.

Longfei-Zhou et al., 2019 [10] proposed a paper related to utilizing electronic twins to create an unique cloud assisted Infrastructure for elder people health monitoring services. In this paper [10], the authors illustrated such as: With the advancement of technologies such as machine learning, cloud services, and the IoT, the digital representation is being used in industries as a quality modeling tool from idea to implementation. Additionally, modeling is critical in the health profession, identified the research on healthcare process development, allocating resources and behavior forecasting. By integrating digital twins and medicine, a modern and improved method of providing highly effective and consistent offerings for aged medical care will also be created. Furthermore, achieving personalized health monitoring across the lifespan of geriatric individualsand integrating the health care virtual environment to actualize truly intelligent health care remaintwo critical difficulties in the period of clinical research. The study [10] proposes a framework for a cloud health system associated with digital twin health care. This is really a unique, generalized and extendable cloud based system for detecting, evaluating and forecasting many components of a patient's health adopting, for instance, personal biomedical applications, with the purpose of improving personal medical administration, particularly for the aged. Cloud digital twin health care aspires to behavioral intentions and confluence between both the virtual and physical worlds of medicine. As a result, a revolutionary development of urban twin health coverage is developed as well as addressed, along with the implementation of a digital twin health care model. Followingthat, a standard structure for digital twin health care is developed based on IoT and its key motivating components are examined. Furthermore, the possibility of several various applicationsis proved as well as a clear example for real-time observation.

III. METHODOLOGY

This paper introduced a new deep learning strategy called Intense Learning Principle (ILP), in which it is derived from the conventional neural network algorithm called Deep Neural Network.The DNN algorithm is known as a user-friendly and robust learning mechanism, in which it is used for evaluating the complex tasks in real-world applications. The same strategy is applied overthis paper to evaluate the complex health care applications using smart device associated with it.

The smart device is interconnected with multiple sensors such as temperature and humidity measurement sensor (DHT11), pulse rate measurement sensor (Pulse Rate Amped) and Gyroscope for estimating the patient position is normal or abnormal. The DHT11 sensor is

used to estimate the temperature and humidity level of the circumstance, in which it is estimate the readings basedon the following equation.

$$T_H \leftarrow \{ \begin{matrix} T \\ W \\ H \end{matrix} \langle \frac{r\ w}{r s} \rangle . X\ 100\% \qquad (1)$$

Where TH indicates the temperature and humidity estimation variable, T indicates temperature, Hindicates the humidity, W indicates Weather, pW indicates the density of water vapor ratio and pSindicates the density of water vapor ratio during saturation. The pulse rate amped sensor estimatethe respective patient heart rate with the help of the following equation, in which it generally uses the blood pump rate to measure the heart beat as well as the following terminology is used to measure it in perfect manner.

$$P^{Rate} \leftarrow \frac{(0) \pm \sqrt{u^2 - B(\Theta)}}{C} \qquad (2)$$

Where the variable P^{Rate} indicates the pulse rate and f(0) indicates the frequency shift resistance, u2 indicates the source frequency level, B(Θ) indicates the target frequency level of the blood flow, C indicates the overall density ratio within 1 minute of timeline. The gyroscope scope sensoractivates with the help of the following equation, in which it estimates the respective patient present position, in which it produces the binary result based on the x and y positions. The generalposition ratio s estimated according to the average of 100 and the levels variate from 70 to 79 andthe above ranges are marked as the false ratio. And the sensor returns the binary results accordingto the mentioned threshold ranges as well as the resultant values are either true or false, in which these values are used to indicate the position is normal or abnormal.

$$(x + y)^n = \sum_{i=1}^{n} \binom{aP}{pP} x^i y^{n-i} \qquad (3)$$

Where x and y indicates the positional variable of the gyroscope readings, aP indicates the actualposition and pP indicates the present position level of the patient. These variations are evaluated upto the dynamic threshold level of n and the range of n is deviated according to the patient healthconditions.

This application is not only intended to design for the hospitals and patients criteria, instead of thatthe application provides support to the guardians as well as to take care of their respective patient without any delay. This process requires proper authentication credentials, in which the security parameters are associated usually with credentials like username and password maintenance. But in this application apart from that, a RFID based authentication system is followed. All the guardians are indicated with proper identity cards, in which the cards are enabled with radio magnetic signals. The card authorization is mandatory while entering into the official applicationto verify the health details of the patient. This provision provides perfect safe guard to the entire system in clear manner. Apart from the RFID credentials the application follows the one-time- password verification for high security management. In this system, an EM-18 RIFD reader with 125 KHz frequency cards are utilized, in which the associated RFID cards are provided to the guardians to represent their identity in clear manner. The following figure, Fig-5 represents the EM-18 RFID reader pin configurations in graphical manner.

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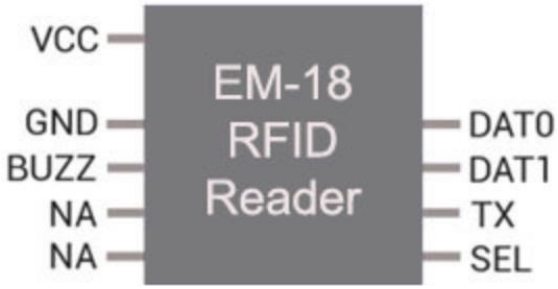

Fig.5 EM-18 RFID Reader Pin Diagram

Health information acquired from individuals must always be stored securely in order to use in the future. Physicians eventually understand their individuals' medication orders, while artificial intelligence remains ineffective without access to huge datasets of information. Data storage, as per the research, seems to be the most promising method of data processing. Moreover, ensuring availability for health care practitioners without sacrificing privacy is a critical challenge [10] that scientists designing health care Internet of Things need to overcome. Furthermore, deep learninghas indeed been consistently highlighted as a technique of strengthening health care schemes in the research [4][7], although that has received little attention. Deep learning has the capacity to detect completely undiscovered correlations in health information, assist doctors and tests, and make personalized suggestions to healthcare professionals. While certain, cloud services infrastructures should really be set up in a way that artificial intelligence can be applied to large amounts of data. The proposed Intense Learning Principle (ILP) accumulates the health oriented data received from the smart device with associated sensors and processes it according to the normalization laws of the dataset, in which the dataset is dynamically generated over the period of testing phase. The processed records are dynamically appended to the dataset for further testing scenario. The manipulations are systematically happens over the server end by using the proposed deep learning strategy.

IV. RESULTS AND DISCUSSIONS

In this section, the experimental analysis of proposed health care monitoring scheme needs to be discussed with graphical proofs in clear manner. The proposed health care monitoring scheme is designed with several latest technology adaptations such as deep learning, smart sensors, RFID Security enhancements and so on. All these features are associated together to build a powerful health care monitoring scheme with respect to the proposed Intense Learning Principle. The learning accuracy of the proposed ILP is improved as compare to the other conventional approaches, in which the training model is generated within the scope of dynamic threshold levels.The levels of the threshold are illustrated clearly in the following figure, Fig-6 in graphical manner.

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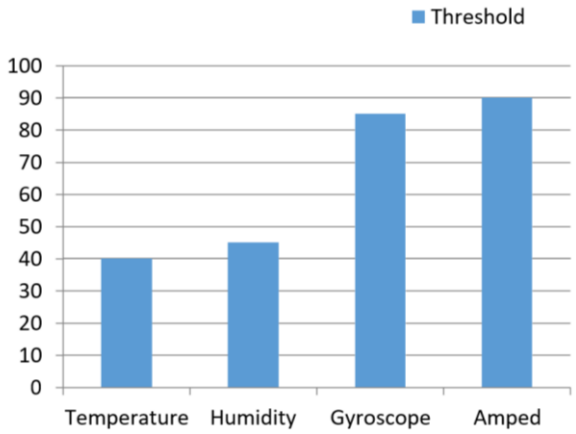

Fig.6 Sensor Unit Threshold Levels

The following figure, Fig-6 illustrates the view of proposed approach data collection accuracy ratio in terms of health information transmitted from the smart device adopted in patient end to the server end for processing. This figure portrays the data reception accuracy by means of evaluating the received data count over the server end, in which it is cross-validated with the data transmitted from the smart device end. This is essential to identify the quality of service provided from the smart device end to customer end with respect to the data ratio. Because the accuracy parameters are highly dependent on the quantity of records sent and quantity of records received. The x-axis illustrates the time period for sending the health information from the smart device end in bytes and the y-axis indicates the quantity of data received over the server end.

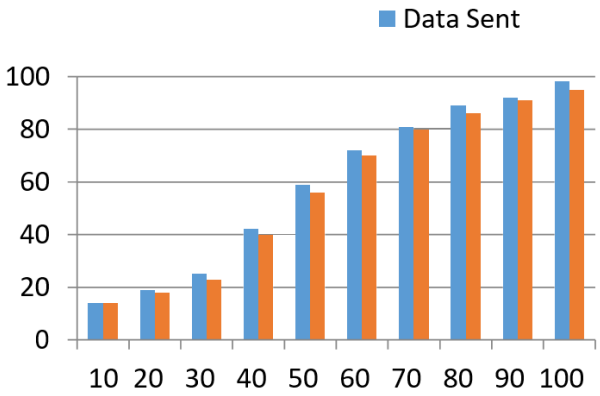

Fig.7 Data Accumulation Ratio Analysis

The following figure, Fig-7 illustrates the view of proposed approach Intense Learning Principle prediction accuracy, in which this accuracy ratio is cross-validated with the traditional Deep Neural Network to prove the efficiency of the proposed approach in clear manner.

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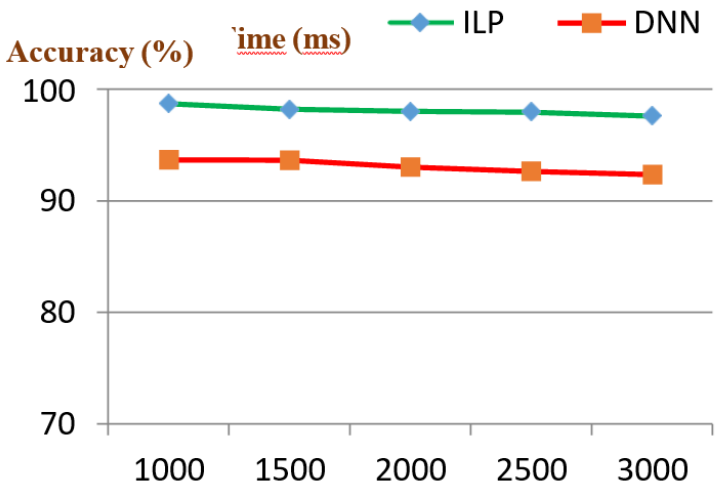

Fig.7 Analysis

V. CONCLUSION AND FUTURE SCOPE

A novel direction for sustainable Internet of Things assisted smart health care system is developed in this work, which may be extended to both significant ideas and those that monitoring patient consideration. Following that, a comprehensive and structured analysis of the province research is offered on each aspect of the suggested methodology. Numerous existing methodologies are available in past to identify the solution for the same issue, but all are stacked up in certain extend. This system provides a clear solution with respect to the adaptation of multiple new technologies in association with the smart health care device. The proposed deep learning strategy called IntenseLearning Principle provides a clear pathway for monitoring the health care system in proper manner without any intervention. The remote server based health data maintenance and storage provides a sufficient relaxation to the organization to manage the huge data in local environment and afraid of the disasters and accidents as well. This case provides an added advantage to the proposed system of health care management as well as its application benefits.

This application shows many specific indications for future studies depending on the review of province innovations in the realms of smart technologies, communication systems standardizationand artificial intelligence. Deep learning and the establishment of a safe although efficient authentication scheme for data storage seem to be the specific aspects where experts can make significant progress in the area of Internet of Things based health care system.

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